

# Department of Energy

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APR 10 2002

Mr. Tom Schneider, Project Manager  
Ohio Environmental Protection Agency  
401 East 5<sup>th</sup> Street  
Dayton, Ohio 45402-2911

DOE-0418-02

Dear Mr. Schneider:

**TRANSMITTAL OF DRAFT COMMENT RESPONSES TO THE OHIO ENVIRONMENTAL PROTECTION AGENCY COMMENTS, REVISED PROJECT SPECIFIC PLAN FOR AREA 3A/4A CHARACTERIZATION AND PRE-CERTIFICATION, REVISED EXCAVATION MONITORING SYSTEM REPORT AND UPDATE TO THE REAL-TIME USER'S MANUAL TO INCORPORATE THE EXCAVATION MONITORING SYSTEM**

Reference: Letter, Johnny Reising to James A. Saric and Tom Schneider, "Transmittal of Excavation Monitoring System Documentation and Responses to the USEPA and OEPA on the Area 3A/4A Excavation Characterization and Pre-Certification Project Specific Plan," dated February 12, 2002

The purpose of this letter is to transmit, for your review and approval, the subject documentation to close-out the remaining comments from you concerning the implementation of the characterization activities of excavation control and pre-certification in Area 3A/4A of the former production area. The enclosed revised Project Specific Plan (PSP) for the characterization and pre-certification of Area 3A/4A has been revised based on the enclosed comment responses as well as the comment responses, which were previously submitted to the United States Environmental Protection Agency (USEPA) and Ohio Environmental Protection Agency (OEPA) (Referenced).

If you should have any comments or questions, please contact Robert Janke at (513) 648-3124.

Sincerely,

Johnny W. Reising  
Fernald Remedial Action  
Project Manager

FEMP:R.J. Janke

Enclosure: As Stated

APR 10 2002

Mr. Tom Schneider

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cc w/enclosure:

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**RESPONSES TO OHIO ENVIRONMENTAL PROTECTION AGENCY COMMENTS TO  
DOE COMMENTS ON OHIO ENVIRONMENTAL PROTECTION AGENCY COMMENTS  
ON THE DRAFT PROJECT SPECIFIC PLAN FOR AREA 3A/4A EXCAVATION  
CHARACTERIZATION AND PRECERTIFICATION AND EXCAVATION  
MONITORING SYSTEM (EMS) DOCUMENTATION**

**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

**PROJECT SPECIFIC PLAN FOR AREA 3A/4A EXCAVATION  
CHARACTERIZATION AND PRECERTIFICATION  
(20200-PSP-0009, REVISION A)**

Commenting Organization: Ohio EPA

Commentor: OFFO

Section #:

Pg. #:

Line #:

Code: C

Original Comment #: 12

**Comment:** As was stated in our original comment, an area of excavation may be expanded with *in situ* scanning but never reduced in size. While the RTC begins by saying "agreed" to our comment, it continues on to completely contradict the comment. *In situ* scanning can **not** be used to delineate a smaller area of excavator than what is planned as the result of physical samples.

**Response:** It is the FEMP's understanding that all predesign above-waste acceptance criteria (WAC) physical sampling results, even when identified in isolation, will represent a volume of necessary above-WAC excavation. Therefore, no real-time scanning that exceeds the uranium WAC will ever over-ride a physical sample that exceeds the uranium WAC. Similar to when a uranium hotspot is identified during certification by a physical sample, even with the lack of confirmation of the hotspot by real-time scanning during the delineation phase, a minimal volume of impacted soil will be removed to acknowledge the presence of the hotspot identified by the physical sample. However, consistent with the Area 3A/4A Integrated Remedial Design Package (Page 3-12), when uranium is the only constituent of concern (COC) driving the above-WAC excavation, real-time monitoring may be used to establish the base of the final above-WAC footprint and refine the above-WAC uranium boundary beyond the locations of above-WAC physical sampling results during the excavation process in certain areas where predesign physical sampling was not sufficient to bound the actual above-WAC volumes.

In terms of the Area 3A/4A excavation control, the remaining, known above-WAC radiological areas are confined to the Incinerator Pad, Plant 9, and Plant 6. The known (based on physical sample results) above-WAC conditions are determined by uranium, technetium-99, and/or PCE. Only the Incinerator Pad area and Plant 6 (based on physical sample results) appear to have distinct uranium-only above-WAC areas. As you are aware, in the Plant 6 area, sufficient predesign characterization data to bound the above-WAC areas are not currently available. During the predesign investigation, the collection of adequate predesign characterization (WAC attainment) data was hampered by the ongoing Decontamination and Decommission activities. As a result, the above-WAC areas were preliminarily drawn largely to the footprint of Plant 6 and/or bounded completely by below-WAC results far away from the suspected source areas. Given the above-WAC excavation in Plant 6 will not start until later this year in the former pickling area and the excavation difficulties which are anticipated to be encountered during the excavation, the FEMP is planning on collecting additional characterization data to better

bound the uranium, technetium-99, and PCE above-WAC areas and, therefore, simplify the excavation/real-time scanning process during excavation.

Action: None.

Commenting Organization: Ohio EPA

Commentator: OFFO

Section #:

Pg. #:

Line #:

Code: C

Original Comment #: 17

Comment: A) During Ohio EPA's review of DOE's RTCs and re-examination of the Draft Area 3A/4A PSP for Excavation Characterization and Precertification, it became apparent that DOE has not laid out a clear excavation process. Sampling for WAC and FRL requires two separate approaches to sampling and disposition. It is not clear in the document on how the excavated material will be handled regarding sampling or disposition. Please provide a flow chart and revised section to clarify the manner in which trenching operations will proceed including sampling and material disposition.

B) It would appear that the EMS will be approved to be used in the Area 3A/4A excavations. Ohio EPA finds this to be a far superior method for scanning the trenches (100% coverage) versus the 50-foot intervals proposed for HPGe tripod measurements. Please remove all reference to using the HPGe tripod for scanning of the trenches.

Response: A) A flowchart will be developed and will replace the current Figure 2-3.

B) Agree that the EMS is a superior method for scanning the trenches and that use of the EMS will be approved for Area 3A/4A excavations. However, the use of the high-purity germanium (HPGe) tripod as a backup should be included in this Project Specific Plan (PSP) in case the EMS equipment is out of service for an extended period of time. Due to qualifying the use of the tripod in trenches as a backup only, the physical sampling approach must be modified. Physical samples, when needed, will be collected from trench material contained in the backhoe bucket.

Action: A) Figure 2-3, Utility Trench Characterization Beyond Design Depth Using HPGe Tripod Option, will be removed and replaced with a flowchart that will address trenching operations.

B) Text in the PSP will be revised to clearly state that the HPGe tripod will be used only as a last resort in case of EMS equipment failure. A paragraph will be added to address the collection of physical samples from trenches.

Commenting Organization: Ohio EPA

Commentator: OFFO

Section #:

Pg. #:

Line #:

Code: C

Original Comment #: 18 and 20

Comment: Ohio EPA agrees with the action of changing the title of the table to clarify that only COCs which are driving excavation will be listed on this table. To assist readers of this document in the future, we request that a footnote be added to this table clarifying that a separate and complete list of COCs for the Production Area will be used for certification.

Response: Agree.

Action: A footnote will be added to Tables 2-1 and 2-4.

**RESPONSES TO COMMENTS ON THE DEVELOPMENT AND DEPLOYMENT OF  
EXCAVATION MONITORING SYSTEM (EMS)  
(20310-RP-0007, REVISION A)**

Commenting Organization: Ohio EPA

Commentator: ODH

Section #: Table 5-1

Pg. #:

Line #:

Code: C

Original Comment #: 1

**Comment:** Table 5-1 of the EMS Manual provides theoretical examples of measurements with geometric corrections. Is there any data to compare actual measurements with appropriate geometric corrections to collocated discrete samples analyzed in a laboratory so the data can be compared as performed in prior method validation studies?

**Response:** No FEMP-specific data has been collected to compare geometry-corrected *in situ* readings to discrete physical samples. In this vein, however, the FEMP has performed an analogous study for flat geometry in the context of the calibration pad. In this effort, which is effectively the reverse of the question in the comment, lab-verified discrete standards placed in the pad produced HPGe readings very close to expected values. This outcome demonstrates our ability to accurately model gamma fluence from a known geometry. There is every reason to expect that similar modeling for other geometries would be accurate as well. As discussed at the Real-Time Work Group Meeting on March 14, 2002, a rectangular array of sources on the calibration pad will allow a detector to be checked for both front face and sidewall response by rotating the detector about its long axis. This measurement approach will be pursued with the EMS in the coming months and the results reported through the Real-Time Work Group. However, recognize in actual field applications, each measurement situation will be assigned to one of a few well-established geometric configurations in a conservative manner (see Response to OEPA Comment No. 6).

**Action:** No action at this time.

Commenting Organization: Ohio EPA

Commentator: ODH

Section #:

Pg. #:

Line #:

Code: General

Original Comment #: 2

**Comment:** Has guidance been developed yet for deployment of real-time radon monitors necessary to obtain radon-corrected radium-226 measurements on vertical surfaces, trenches, or steep slopes?

**Response:** Guidance is currently being developed for the deployment of radon monitors used for correcting radium-226 measurements in non-flat terrain. A valid radon monitor placement is not much of an issue for wide-open excavations, but for a narrow pipe trench, other factors must be considered. Basically, as the solid angle of the soil being viewed increases, the solid angle of the air above decreases. Thus, there should be less radon interference. Radon corrections may be necessary during precertification of radium-226. Radon monitoring will be performed with a co-located HPGe detector in order to provide similar geometry corrections.

**Action:** No action.

**RESPONSES TO COMMENTS ON EMS MEASUREMENTS  
SECTION 2.6 OF THE DRAFT USER GUIDELINES, MEASUREMENT  
STRATEGIES, AND OPERATIONAL FACTORS FOR DEPLOYMENT  
OF *IN SITU* GAMMA SPECTROMETRY AT THE FERNALD SITE  
(20701-RP-0006, REVISION B, SECTION 2.6)**

Commenting Organization: Ohio EPA

Commentator: ODH

Section #: 2.6

Pg. #: 2.6-1

Line #: 2<sup>nd</sup> Paragraph, 2<sup>nd</sup> Line

Code: C

Original Comment #: 6

**Comment:** Section 2.6 of the draft EMS Measurements for the User's Manual states the EMS can be used on soft or wet ground as may be typical of a deep excavation. Notwithstanding corrections available for pooled water, this seems somewhat contrary to existing guidance in Section 4.11.1 of the User's Manual as soil saturated with water may lead to anomalously low results due to fluence attenuation by the water present.

**Response:** The EMS will not be used in soils that have moisture, over large areas, in excess of the range for which moisture corrections can be reasonably applied. Small areas of excess moisture or pooled water within the field of view of the detector can be tolerated as indicated in the User's Manual (Section 4.9.6 and Figure 4.9-7), as long as they are not directly under the detector and occupy a relatively small portion of the field of view. The field lead in charge will refer to the User's Manual when determining whether soil moisture conditions are acceptable for *in situ* gamma measurements.

**Action:** No action.

Commenting Organization: Ohio EPA

Commentator: ODH

Section #: 2.6.6

Pg. #: 2.6-10

Line #: Figure 2.6-2

Code: C

Original Comment #: 2

**Comment:** Section 2.6.2 of the draft EMS Measurements mentions under guidance the need in some circumstances when considering making geometry corrections to investigate whether contamination is uniformly distributed. Figure 2.6-2 depicts the procedure for application of geometric corrections for non-flat terrain. It seems appropriate to include a step on the graphic of an action to investigate an area for uniformity of contamination as needed. In addition, hand-held instruments used to evaluate heterogeneity at depth would also have their measurements affected by geometry somewhat as they are subject to the same influences as the NaI and HPGe systems.

**Response:** Agree. A step will be added to Figure 5-3 to indicate that a uniformity check will be made prior to application of any geometry correction. Regarding hand-held instruments, presumably they will be scanned at close proximity to the affected surfaces, which will minimize the effects of non-flat geometry. Other means of checking uniformity will also be used, including moving the EMS-mounted detector around within the confines of the area in question and monitoring detector response. For example, little change in response would be expected for uniform contamination inside a trench or well geometry, whereas, localized contamination would produce a changing response.

**Action:** A note will be added to Figure 5-3 in the EMS Manual and to Figure 2.6-3 in the User's Manual to indicate a check for uniformity prior to the application of any geometry correction.

Commenting Organization: Ohio EPA

Commentator: ODH

Section #:

Pg. #:

Line #:

Code: C

Original Comment #: 3

**Comment:** The EMS Manual states that geometric corrections, when needed, will be handled manually initially. Prior to deployment of the EMS, there should be a clear and concise SOP detailing how the myriad non-flat geometries encountered will be categorized and corrected for in a manner which will expedite excavation/precertification decisions.

**Response:** An operating procedure is not needed to describe the selection of the appropriate geometry, as two standard configurations describe the conditions to be encountered in the field. First, a trench geometry may be encountered when utility lines and building footers are removed. This geometry corresponds to the case of a vertical wall. Second, a 2:1 slope geometry will be encountered for most of the excavation area.

A simple software routine is used to calculate the correction factor for the two standard configurations. Input parameter needed for the calculation include detector height above the surface (generally 31 cm), height of the wall or slope (measured to the top of the wall or slope from the surface being measured), and the horizontal distance from the center of the detector to the top of the wall or slope. These parameters are obtained with the Global Positioning System (GPS) system mounted to the EMS. A discussion of the expected excavation geometry and examples of the correction calculations will be inserted into the EMS manual.

**Action:** Section 5.3.3 of the EMS Manual and Section 2.6 of the User's Manual will be revised to incorporate the discussion on geometry corrections and examples of the correction calculations.

#### **RESPONSES TO COMMENTS ON THE EMS II ACCEPTANCE TESTING PLAN (20310-PL-0003-TC, REVISION 1, PCN 1)**

Commenting Organization: Ohio EPA

Commentator: ODH

Section #: Attachment A

Pg. #: A-2

Line #: Requirement 7

Code: C

Original Comment #: 1

**Comment:** The EMS II Acceptance Testing Plan mentions in Attachment A Requirement #7 that a collimator assembly has been purchased for HPGe measurements using a collimator to better define certain areas of potential contamination. Has a calibration been performed over the viewing area of the detector with the collimator in place? The deployment of a collimator should be referenced in the User's Manual.

**Response:** No testing has been performed with an EMS detector equipped with a collimator. Such testing would be performed prior to the use of the purchased collimator. The calibration pad will be evaluated for this purpose. It is currently designed for an unshielded detector. The uniformity of the fluence field produced with the current layout of standards will be compared to the reduced field of view of the collimated detector to determine whether a revised layout is needed. Any revisions to the calibration pad would be checked with an HPGe detector. When ready for use, a section on the deployment of collimator-equipped detectors will be added to the User's Manual.

**Action:** No immediate action, however, after development and testing of collimator for EMS deployment, an update will be developed to the User's Manual for the EMS and will be submitted to the regulators for approval prior to deployment.

## 2.6 EMS MEASUREMENTS

### Background

The Excavation Monitoring System (EMS) is a self-contained gamma detection system. It is capable of deploying the NaI and HPGe gamma spectrometry systems that have been in routine use at the FEMP. It is deployed on a standard excavator and includes a self-righting vertical mast, with an attachment for mounting a gamma detector. The vertical mast is suspended from a horizontal platform that is coupled to the arm of the excavator and holds an on-board computer, gamma ray spectral acquisition equipment, global positioning system (GPS) and laser-based location measurement systems, and data transmission equipment. The GPS and laser-based position measurement systems provide redundant means of measuring the location at which each gamma spectral measurement is performed. Other major components of the system include excavator cab and support van computers, data processing software, and display screen. If needed, a 2-foot or 4-foot extension can be added to the vertical arm of the unit to extend the reach of the system into deeper excavations.

The EMS will be deployed in non-standard survey situations that cannot be handled by the other platforms, for example, surveys of pits, trenches, mounds, vertical surfaces, soft ground, or locations where access is difficult or unsafe. In these situations, using the EMS can avoid placing workers into dangerous situations and reduce their potential exposure, thereby advancing ALARA and worker health and safety objectives. The EMS provides a substantial improvement in meeting ALARA objectives compared to what could be accomplished with other available real time platforms.

Real-time gamma measurements can be made in several modes, including stationary measurements at a prescribed detector height or offset and mobile scanning measurements with either detector at a prescribed detector height and scanning speed. Either gross activity or spectrometric measurements can be collected in any of these modes. All stationary or mobile measurements are tagged with detector location as determined by the on-board GPS or laser-based systems. The movement of the EMS-mounted detector over the survey area is tracked using either the GPS or a laser-based tracking system that traces detector location on display screens in the excavator cab and in the support van.

The EMS may be used in the same phases of the FEMP soil remediation program as the other real-time platforms, namely in excavation predesign, excavation support, and precertification. The main activities associated with these program phases are delineation of excavation boundaries, identification of soil with uranium concentrations above the waste acceptance criteria (WAC) for the On-Site Disposal Facility

(OSDF), identification of hotspots, and checking residual contaminant levels to confirm the effectiveness of cleanup actions. The use of the EMS is discussed in a report entitled "Development and Deployment of the Excavation Monitoring System," (DOE 2002a), hereafter called the "EMS Manual."

#### EMS Description and Operation

The main component of the EMS, which is mounted on the arm of a standard excavator, is called the excavator tool (ET). A drawing of the ET is shown in Figure 2.6-1, which identifies the major components of the device. The ET stands approximately 72 inches tall, by 32 inches wide, by 50 inches deep, with HPGe detector mounted, but excluding the available 2-foot or 4-foot detector mount extensions. The entire unit weighs roughly 200 pounds, while the removable detector assembly weighs roughly 46 pounds. Other major components of the EMS include computers and displays located in the excavator cab and in the support van.

The mechanical components of the ET include an excavator adapter, which allows fast and simple attachment to a hydraulic coupler mounted on the arm of an excavator. The excavator adapter is attached to the main platform of the unit on which are mounted the system computer and other system communications and GPS components. The horizontal unit is articulated and can pivot about a swing damper that provides half of the freedom of movement that allows the mast assembly to maintain a vertical orientation. A similar damper, mounted at right angles to the first affords the other half of the freedom of movement, and connects the mast assembly to the horizontal platform.

A gamma-sensitive detector is suspended from the excavator arm at the end of the mast assembly. The signal processing modules, antennae and other electronic equipment are housed on the horizontal platform, referred to as the boom assembly, located at the top of the mast assembly. A 2-foot or 4-foot extension rod may be attached between the lower end of the mast assembly and the detector to enable the detector to reach the bottom of deeper excavations. Each detector assembly is equipped with four ultrasonic proximity sensors, which provide collision warning signals when the detector approaches an excavation wall or other nearby object. Each detector assembly is also equipped with a look-down laser range finder capable of measuring the distance to the surface being surveyed. The laser range finder functions as a collision warning system, but more importantly, it allows positioning of the detector at the appropriate height above the surface being surveyed in accordance with standard procedures.

Three computers are used in the EMS, one mounted on the ET, one in the excavator cab, and one in the support van situated near the excavator. The ET-mounted computer performs important signal processing

1 and data transmission functions associated with the collection of measurement and position data from  
2 sensors and detectors on the ET. The integrated data are transmitted via a wireless Ethernet connection to  
3 the other two computers, which display and record the data as needed. Display panels on the excavator  
4 cab and support van computers provide the information to the excavator operator and EMS operators  
5 needed to position the device and interpret gamma readings as they are made.

6  
7 Two main types of data result from EMS operations, namely measurement location data and gamma  
8 spectral data. A number of sensors, receivers, and detectors generate the data. The EMS uses the three  
9 mentioned computers for data collection, processing, and display. These inputs are routed through a  
10 peripheral component interconnect (PCI) bus to a Cisco Wireless Ethernet Adapter, which transmits the  
11 data to the excavator- and van-mounted computers, which have corresponding wireless Ethernet  
12 receivers. Data are ultimately transferred to the Sitewide Environmental Database (SED) for further use  
13 and archiving.

14  
15 The excavator cab computer and display serve as the excavator operator's main interface with the system,  
16 in addition to his visual view of the ET or of someone who is spotting for him. The display screen is  
17 mounted in a convenient location in the excavator cab, and features a touch screen display. Touching the  
18 "Draw Scaled Coverage" button on the screen will pull up a scaled coverage plot similar to that available  
19 on other RMS systems.

20  
21 Other information on the excavator cab display includes latitude and longitude readings from the GPS or  
22 ArcSecond laser-based positioning systems, detector travel speed, and detector-to-ground offset as  
23 determined by the detector-mounted laser range finder. Also displayed are four lateral hazard warning  
24 lights activated when the ET approaches a lateral object within a preset limit as determined from readings  
25 from the four laterally mounted ultrasonic sensors on the ET. This information is used primarily to  
26 protect the detectors from collisions during scanning.

27  
28 The support van computer is used to control data acquisition functions of the devices mounted on the  
29 excavator tool, mainly the gamma detectors and positioning systems. System software is capable of  
30 controlling and acquiring data from both NaI and HPGe detectors. The system can be operated in either  
31 static or mobile scanning modes. Setup and control functions in the van can select between static and  
32 repeated scanning measurements and allow setting measurement duration in either live time or real  
33 (actual) time.

The van display can be toggled between plan view and spectrum view. Gamma spectra are displayed as they accumulate over time in terms of counts recorded per MCA channel. The Environmental Gamma Analysis Software (EGAS), when loaded can analyze spectral data from either NaI or HPGe detectors to produce a calibrated energy spectrum. The software can further analyze such spectra to determine the identities and activities of the radionuclides corresponding to the recorded spectral peaks. Worksheet and log-file functions can also be loaded into the system.

Both manual and computer assisted quality control (QC) checks are performed on the data in accordance with Appendix H of the Sitewide CERCLA Quality Assurance Project Plan (SCQ) which describes the *in situ* gamma spectrometry QA/QC program. Fully processed and reviewed measurements collected on a given day, or portion of a day, are transferred to the Real-Time Directory of the FEMP Local Area Network (LAN) via a Wireless Ethernet connection, or computer diskettes. After QC checks are performed on the data on the LAN, approved data are sent to the SED for storage and archiving.

#### EMS Calibration

The HPGe and NaI detectors used with the EMS are calibrated on the FEMP calibration pad following the approach used for the other platforms, as discussed in the Calibration of NaI *In Situ* Gamma Spectroscopy Systems Report (DOE 2001). The efficiencies determined for the detector in December 2001 are presented in the EMS Report.

#### EMS Applications

Expected applications of the EMS in the Former Production Area include use in elevated contamination areas and in difficult-to-access areas where use of other available platforms would pose a physical and/or contamination hazard to workers. In all probability, this will include use of the EMS in deep excavations, with sloped walls and utility trenches with vertical walls. Use of the EMS would always be preferred in these areas. However, its use is limited to areas that are accessible to the large excavator on which the system is mounted.

The use of *in situ* measurements in support of excavation activities is described in the Sitewide Excavation Plan (DOE 1998a), and the methods for performing these measurements using the available *in situ* gamma detector platforms is detailed in this manual. Whenever possible, the principles and procedures given in this manual for performing these functions will be followed for all EMS measurements.

Because of the ability of the EMS to deploy both NaI and HPGe detectors for either fixed position or mobile measurements, it can be used to make all the measurements made by the currently used platforms. In situations where either the EMS or current systems could be used, the choice will depend on the suitability of the platform to the area, including the size of the area and the time required for performing surveys.

### Geometry Corrections

*In situ* gamma measurements are influenced by measurement geometry. Detectors calibrated to measure radionuclide concentrations in surface soils on flat ground will give a higher or lower result for the same soil concentration when the measurement geometry (i.e., the soil surface contributing to the reading) is not flat. The changes in the results are completely predictable from geometric considerations. When a gamma detector is deployed in a trench or other depression, the results will be biased high, whereas the same detector placed over a soil mound will provide erroneously low results. Correction factors for various non-flat geometries have been computed and are presented in EML-603, "Fluence Evaluations For Applications of *In Situ* Gamma Spectroscopy in Non-Flat Terrain" (Miller 1999). This report serves as the basis of geometry corrections that will be applied to *in situ* gamma measurements made at the FEMP, including those made with the EMS. The application of these correction factors to EMS detector readings is discussed further in the EMS Manual.

Under EML-603, corrections for non-flat terrain require the determination of the total solid angle subtended by the surface contributing to the reading. For flat geometry, the solid angle is  $2\pi$  steradians. To correct readings calibrated to  $2\pi$  geometry, the solid angle subtended by the non-flat terrain,  $\Omega$ , is divided by  $2\pi$  to yield a correction factor. Correction factors for measurements in trenches or excavations will have values between 1 and 2. Non-flat readings are then corrected by dividing by this factor.

To determine the solid angle subtended by the non-flat terrain, some simple information on the geometry is needed. In the case of a depression such as a trench (Figure 2.6-2), the information needed includes H, the depth of the excavation; h, the height of the detector from the floor of the excavation; and X, the horizontal distance from detector to the top edge of the wall of the excavation. The values of H, h, and X are used to determine the angle from the detector to the excavation top edge, known as the horizon angle,  $\theta$ . The solid angle,  $\Omega$ , can then be determined using equations in EML-603 for various pit shapes. An interesting outcome of the theory developed in EML-603 is that the solid angle subtended by soil in trench geometry is independent of the slope of the trench wall. That is, the geometric correction factor for

1 a trench with sloped walls will be the same as that for a vertical-walled trench provided that the horizon  
2 angle and the depth of the two trenches are the same.

3  
4 Figure 2.6-2 depicts the relevant dimensions of two different trenches along with the computed solid  
5 angle and resultant geometric correction factor for each case. This figure illustrates the fact that the  
6 geometric correction factor increases as the depth of the trench increases. The correction factor will also  
7 increase as the detector is moved closer to a trench wall. Isotopic concentrations determined from gamma  
8 spectra would be divided by the applicable correction factor to yield properly corrected results. Detailed  
9 instructions on making geometric corrections can be found in the EMS Manual and EML-603.

10  
11 For all trench or excavation geometries, the correction factor will be greater than 1. Thus for nearly all  
12 cases that will be encountered in FEMP excavations, uncorrected *in situ* measurement results will be  
13 biased high. That is, uncorrected measurements are conservative and must be divided by a number larger  
14 than one to obtain the corrected result. A conservative positive bias would lead to unnecessary  
15 excavation. Therefore, corrections for trench geometry will be applied to obtain more accurate  
16 measurements.

17  
18 Figure 2.6-3 shows the decision process for making geometric corrections. Given the positive bias for all  
19 below-grade readings, isotopic results below the action levels will not require correction because any such  
20 corrections would only reduce the readings further. Conversely, all readings in excess of twice the action  
21 levels would indicate corrected results above the action level because the maximum correction for  
22 geometry is a factor of two. Readings between the action level and twice the action level are thus  
23 inconclusive and warrant an examination of contaminant homogeneity prior to applying a correction for  
24 geometry.

### 25 26 Operational Considerations

27 Excavation characterization support with the EMS will be carried out in a rapid turnaround fashion as is  
28 currently done with the other *in situ* gamma spectrometry systems. The EMS support van will perform  
29 data reduction, review, and mapping tasks. Every effort will be made to produce excavation maps based  
30 on EMS data within 24 hours of data collection. In this way, excavation activities can proceed with  
31 minimal interruption. It may be possible for characterization and excavation activities to be conducted at  
32 the same time in different parts of an excavation area.

To expedite the process, interpretation of data with respect to WAC, hotspot, or FRL criteria will be based as much as possible on data uncorrected for geometry. As shown in Figure 2.6-3, when readings are near the respective criteria, the affected area will be flagged for further analysis including a check to determine whether contaminants appear to be homogeneously distributed, particularly with regard to depth, and corrections for geometry. In this regard, HPGe measurements at varying detector heights (possibly with collimation) will be most useful in determining the uniformity of the radionuclide distribution. To be conservative, if it appears that the contaminants are not uniformly distributed, geometric correction factors will not be applied to the data. No excavation would take place in the flagged area until the corrected results were available. It is expected that the necessary geometric measurements needed to implement the corrections could be performed shortly after the generation of measurements that are in the inconclusive range.

In time sequence, real-time EMS data will be processed in the mapping van to generate uncorrected measurements within an hour or two of data collection. In many cases it will be possible to measure the required pit dimensions for corrections on the same day. Geometric corrections will be computed on the basis of the equations provided in EML-603. Excavation maps generated from the corrected data are expected to be available by the end of the following workday in most cases.

#### 2.6.1 EMS Strengths and Limitations

##### 2.6.1.1 EMS Strengths

- Use of the EMS can greatly reduce hazards to worker and worker exposure when working in inaccessible areas or in contamination areas
- EMS can be used in areas that cannot be surveyed by any other platform
- EMS can deploy both NaI and HPGe detectors
- EMS can perform all of the measurement functions of the other real-time platforms
- The EMS excavator can operate in soft soil (if *in situ* moisture is less than 40 percent)
- EMS facilitates a continuous excavation process.

2.6.1.2 EMS Limitations

- The large excavator that supports the EMS requires wide and high access to survey areas
- The HPGe detector is not provided with physical protection to limit damage to the detector from collisions
- Geometric corrections for measurements in non-flat terrain may be required (as for any real-time platform).

2.6.2 Guidance

- Refer to all appropriate reference manuals when deploying the EMS which include this manual and the following:
  - Development and Deployment of the EMS (EMS Manual, DOE 2002a)
  - Sitewide Excavation Plan (DOE 1998a)
  - Implementation Plan for the active excavation area
  - Project Specific Plans for Excavation Characterization and Precertification
  - Calibration of NaI *In Situ* Gamma Spectrometry Systems (DOE 2001)
  - Appendix H of the Sitewide CERCLA Quality Assurance Project Plan, *In Situ* Gamma Spectrometry QA/QC Program
  - EML-603, Fluence Evaluations For Applications of *In Situ* Gamma Spectroscopy in Non-Flat Terrain (Miller 1999)
  - EMS II Acceptance Testing Plan (DOE 2002b).
- Coordinate excavation and characterization activities. Consider the need to use the EMS inside the excavation footprint.
- Determine which detector (NaI or HPGe) will be required for various purposes. See the reference documents mentioned.
- Follow the procedures in this manual for performing various measurement functions, consistent with the other real-time platforms.
- Determine if geometry corrections for non-flat terrain are needed. Follow the EMS manual. In cases where the uncorrected concentration is above a trigger level and the corrected concentration is below the trigger level, the affected area must be investigated further to ensure that the contamination is uniformly distributed. If contamination is not uniformly distributed, the geometry correction shall not be applied.

2.6.3 See Also

- 2.1 Overview of Uses of *In Situ* Gamma Systems in FEMP Soil Remediation
- 4.2 RTRAK Single Measurement Field of View
- 4.5 Trigger Levels
- 4.8 RTRAK Total Activity Data Interpretation
- 4.11 Environmental Influences on *In Situ* Gamma Spectrometry Data
- 4.12 Shine
- 4.14 Time Required for *In Situ* Gamma Spectrometry Measurements
- 4.15 Seasonal Precautions
- 4.16 Mapping Conventions
- 5.1 Minimum Detectable Concentrations
- 5.3 Radium-226 Corrections
- 5.4 Data Review and Validation
- 5.6 Field Quality Control Considerations
- 5.7 Positioning and Surveying

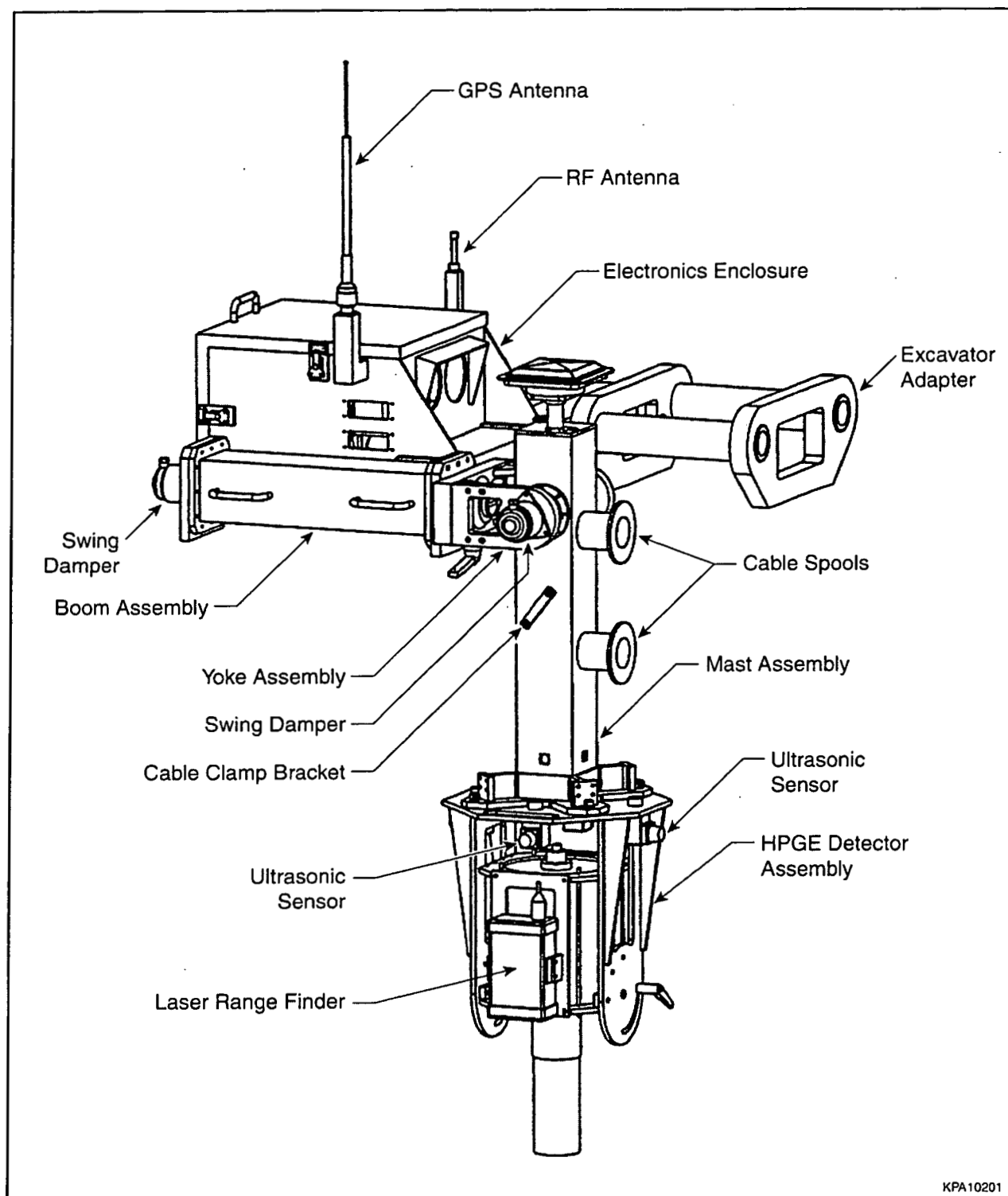
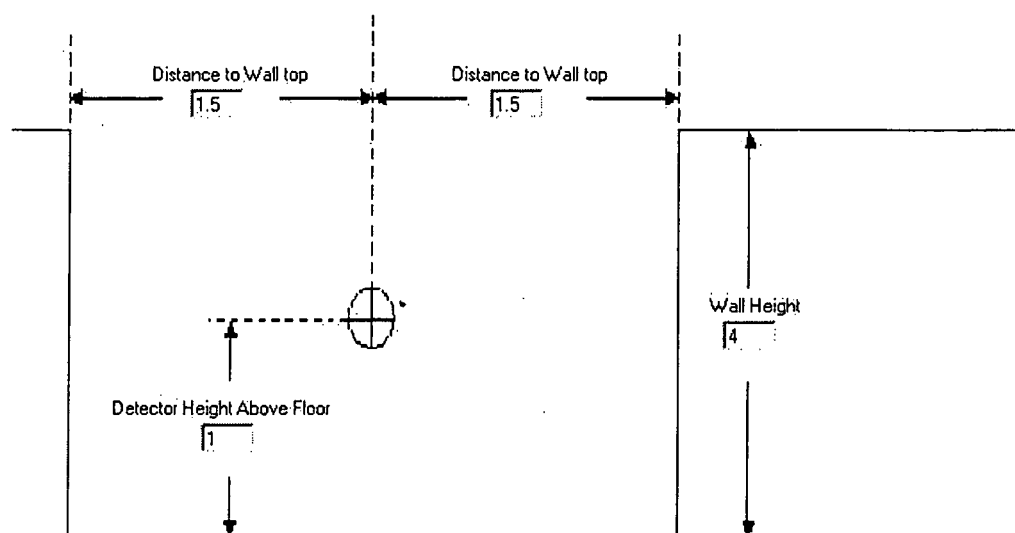


Figure 2.6-1 The Excavator Mounted Portion of the EMS with HPGe Detector Attachment

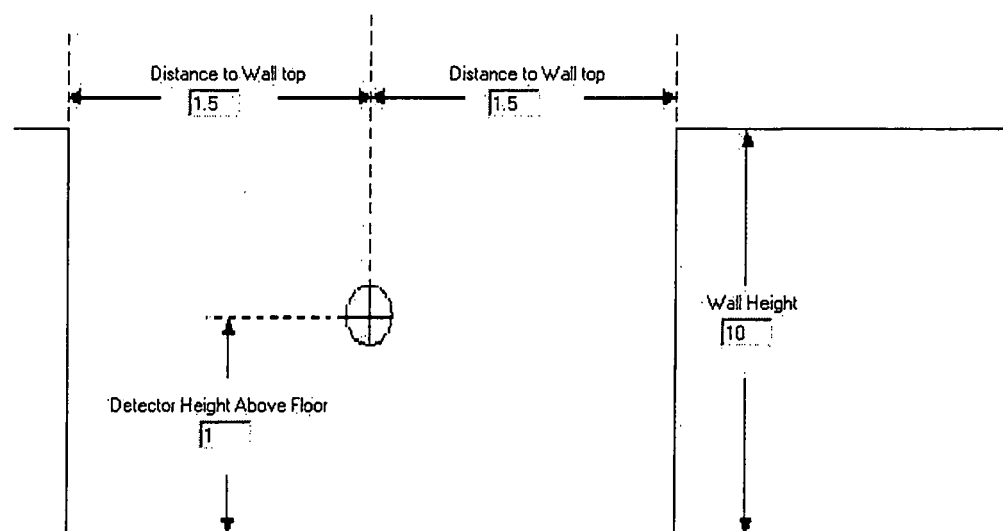
17



Solid Angle (units of pi) = 3.41  
Concentration Correction Factor = 1.7

All Units in Feet

Change to Meters



Solid Angle (units of pi) = 3.79  
Concentration Correction Factor = 1.89

All Units in Feet

Change to Meters

Figure 2.6-2 Factors that Effect Geometric Corrections for Non-Flat Terrain

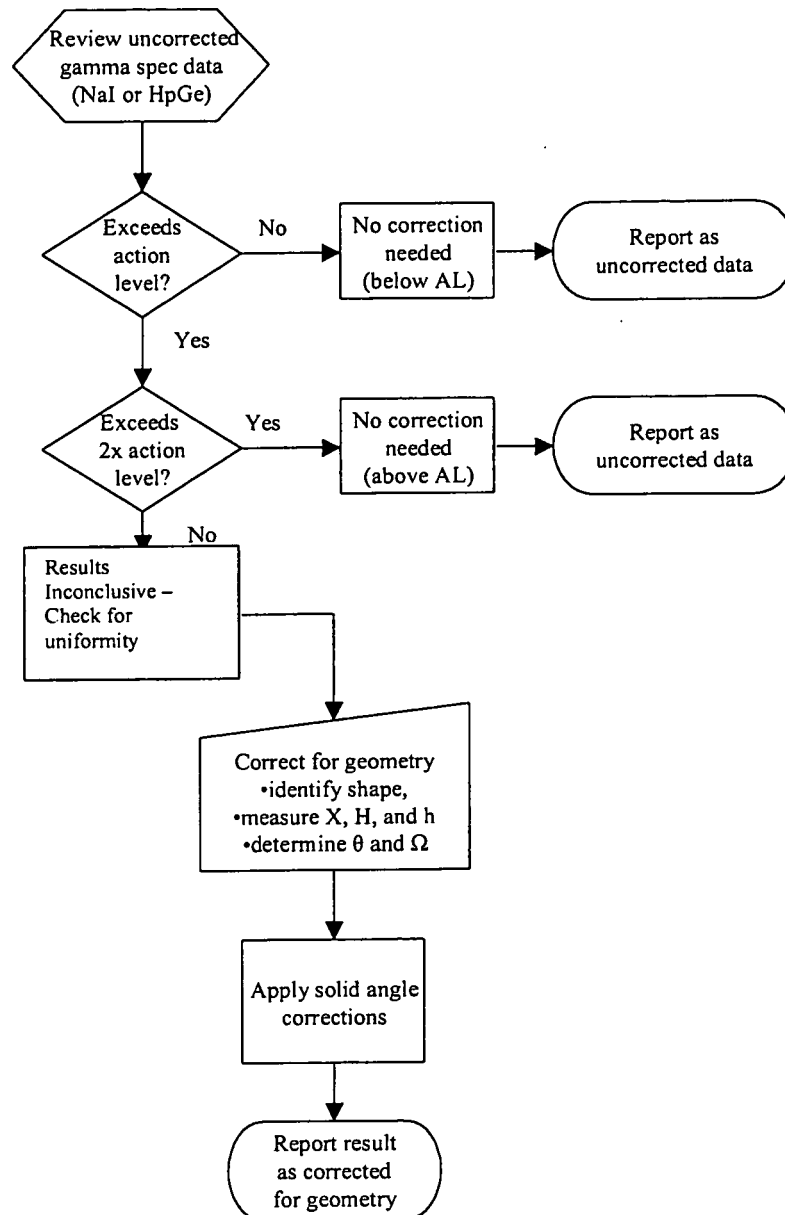


Figure 2.6-3 Procedure for Application of Geometric Corrections for Non-Flat Terrain